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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H01J 37/244 | A1 | (11) International Publication Number: WO 98/40906 | (43) International Publication Date: 17 September 1998 (17.09.98)

(21) International Application Number: PCT/CZ98/00014

(22) International Filing Date: 9 March 1998 (09.03.98)

(30) Priority Data:
PV 770-97 13 March 1997 (13.03.97) CZ

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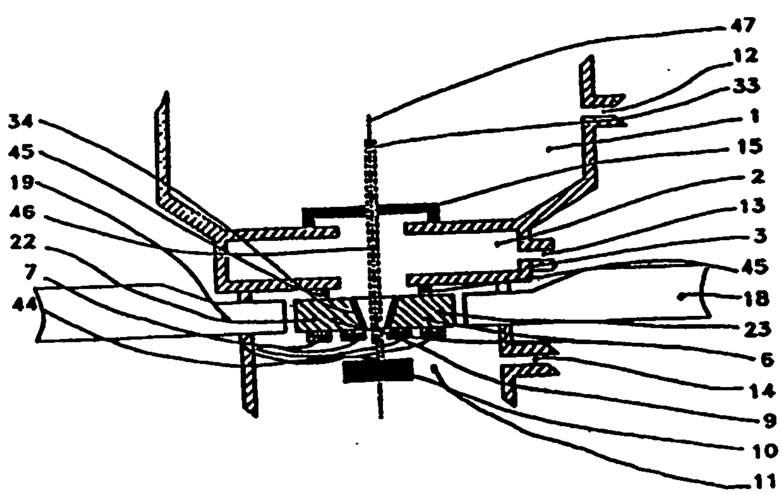
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: SCANNING ELECTRON MICROSCOPE DETECTION SYSTEM



(57) Abstract

The detection system of the scanning electron microscope with the tube separated from the sample chamber (11) by means of the differential chamber (2) consists of the single-crystal scintillator (6) with the aperture stop (9); said single-crystal scintillator (6) is divided into two halves, and based on double yttrium-aluminium oxides or on yttrium silicate activated by trivalent cerium, and having the central conical opening (46), smaller base of which is on the side near to incidence of the primary electron beams, and forms the aperture stop (9). Said conical opening (46) is coated with the reflecting metal layer (37) on the contact areas of the both halves, and with the reflective layer (34) of dielectric and heavy metal on its inner surface. The single-crystal scintillator (6) is placed between the left and the right lightguides (18, 19) in space of the sample chamber (11) above the sample (10). From the external bottom (3) of the differential chamber, it is separated with the sealing (45), and from the side of the sample (10) placing, it is equipped with the circular electrode system (7) consisting of at least two electrodes (27, 28) symmetrical around the axis (47) of the primary electron beams (33).

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SCANNING ELECTRON MICROSCOPE DETECTION SYSTEM

The technical field

The invention relates to a scanning electron microscope for observation of samples and processes in wet or liquid environment.

The state of the art

The scanning electron microscope with the tube separated from the sample chamber by the differential chamber allowing samples observation by means of an electron beam and detection of back scattered or emitted signal electrons at pressure, which is higher than the vacuum in the microscope tube and than the pressure in the differential chamber are, is described eg. in EP 022,356 (US 4,596,928) and EP 330,310 (US 4,823,006) and indicated as the environmental scanning electron microscope. This microscope can achieve a high resolution of electron images of wet, possibly non-conductive samples, eg. biological or vegetable tissues, foods, plastics and ceramics which can be hardly displayed under usual vacuum conditions of the scanning electron microscope. Dynamic processes, eg. liquid flow, chemical reactions, crystallization, dissolution and other processes proceeding under comparatively high pressures of water vapour can be observed with the environmental scanning electron microscope.

The mentioned EP 022,356 (US 4,596,928) together with US 4,992,662 also desribe the separation of the microscope tube from the sample chamber containing gas with relatively high pressure. The separation of high vacuum from very low vacuum, as well as the simultaneous detection of signal electrons and ions by means of an aperture stop and an electrode in the lens placed in the microscope tube to be contained, are also described in already quoted EP 330,310 (US 4,823,006). The use of gas medium of the sample chamber for an amplification of secondary electrons emitted from the sample after the incidence of primary electron beams upon the sample is described in the US patent No. 4,785,182. Further, the arrangement for the detection of signal electrons and ions using some circular electrodes with different voltages is described in the US patent No. 4,897,545 (WO 90/04261). The fact, that it

solves neither undesirable signal collections nor possible noise elimination, is its disadvantage. It also does not solve the separation of secondary electrons from back scattered electrons, which minimizes the resolving power of the microscope. If the electrode is placed above the sample according to the US patent No. 4,880,976 (WO 88/01099), emission of ions originated by the collision of secondary electrons with gas molecules is used for secondary electron detections. The disadvantage is that the ionized molecules of gases generated by back scattered electrons are not separated, which has a negative impact on the resolving power of the microscope. In the US patent No. 5,362,964 the electrode integrated with the aperture stop is given. The electrode is placed above a circular wire electrode under which the sample is positioned. The secondary electrons generated from the sample are detected by the circular wire electrode while the undesirable secondary electrons generated after the collision of back scattered electrons with gas molecules are detected by the electrode integrated with the aperture stop. However, it is not resulting in a clear image of secondary electrons but in an image formed by a higher portion of secondary electrons and a lower portion of back scattered electrons, which only causes the topographical constrast increasing.

The detector of back scattered electrons is solved by the arrangement according to already quoted EP 022,356 (US 4,596,928) the subject-matter of which is the aperture stop constituted by scintillation material or semiconductor detector; the aperture stop separates vacuum and pressure mediums. The disadvantage of this invention is that it records only the material constrast, not the topographical contrast. Also the scintillation detector devided into two halves for reading signals is known; it allows to gain the topographical contrast but it reduces the signal of back scattered electrons as a result of their shielding with the aperture stop material. The disadvantage of semiconductor detectors of back scattered electrons is also to incline to easy contamination of their surfaces which is increased especially in connection with an increase of pressure and humidity in the sample chamber, which has a negative influence on the detector efficiency.

The nature of the invention

The above mentioned disadvantages are eliminated by the detection system in the scanning electron microscope with the tube separated from the sample chamber by means of the differential chamber. The detection system is composed of a single-crystal scintillator with

the aperture stop; the scintilator is divided into two halves. The single-crystal scintillator based on double yttrium-aluminium oxides or on yttrium silicates being activated by trivalent cerium have a conical opening in its centre, smaller base of which is on the side near to incidence of the primary electron beams, and forms the aperture stop. The conical opening has a reflecting metal layer on contact areas of both halves, and the reflecting layer of dielectic and heavy metal on its inner surface. The single-crystal scintillator is situated between right and left lightguides in the sample chamber above the sample. From the external bottom of the differential chamber, the single-crystal scintillator is separated using a sealing; on the side where the sample is positioned, it has a circular electrode system containing at least two electrodes being symmetrical around the axis of the primary electron beams.

The detection system can be arranged in two levels. In this case the single-crystal scintillator forms the first level. The single-crystal scintillator of the second level, also based on double yttrium-aluminium oxides or on yttrium silicates being activated by trivalent cerium, and divided into two halves, is positioned co-axially over the single-crystal scintillator of the first level. The single-crystal scintillator of the second level has the second conical opening in its centre having the reflecting metal layer on the contact surfaces of the both halves. Said single-crystal scintillator of the second level, coated with the ring of the reflecting layer of dielectric and heavy metal from the side reversed to incidence of the primary electron beams, and having greater base of the second conical opening being situated on the side near to incidence of the primary electron beams, is positioned between the left and the right lightguides of the second level in the differential chamber, and it is provided with the circular electrode on its bottom base.

In the both above mentioned cases, it is advantageous, if a single-pole magnetic lens is situated below the single-crystal scintillator respectively below the single-crystal scintillator of the first level. In this way, the collection of secondary electrons being incident upon the electrode system will be better.

The single-crystal scintillators of the first and the second levels are advantageously constituted by circular, square or rectagular plates divided into two halves symmetrically.

For a correct function of the detection system, the following arrangement is advantegeous: the conical openings in the single-crystal scintillators of the first as well as the second levels have an angle 40°-70°.

Better transmission of light through the single-crystal scintillator - the lightguide interface is provided by the arrangement when peripheral jackets of the halves of the single-crystal scintillators of the first and the second levels are coated with antireflecting dielectric layers.

To obtain the desired parameters of the device, it is advantageous if the right and the left single-crystal scintillators of the first level as well as the left and the right single-crystal scintillators of the second level are made from single crystals of yttrium-alluminium garnet doped with cerium or from single crystals of yttrium-aluminium perovskite doped with cerium or from single crystals of yttrium silicates doped with cerium.

Further, for utilization of specific properties of individual materials, the arrangement is advantageous, when the left single-crystal scintilators of the second and the first levels are combined from single crystals of yttrium-aluminium garnet doped with cerium or from single crystals of yttrium-aluminium perovskite doped with cerium or from yttrium silicate doped with cerium.

To prevent a light transmission from one half of the scintilator to the other one, the arrangement is advantageous when the contact areas of the halves of the first and the second levels have the reflecting dielectric layers under the reflecting metal layers.

From the point of view of a correct function, it is also advantageous if the electrodes of the circular electrode system of the single-crystal scintilator of the first level, and the circular electrode located on the bottom base of the single-crystal scintillator of the second level are constituted by conductive oxide layers.

Further, from the point of view of an optimal function, it is also advantageous if the reflecting layers of dielectric and heavy metal are 100-1000 nm thick, and the conductive oxide layers of the circular electrode and the circular electrode system are 0.5-10 nm thick.

The detection system according to the invention enables sufficiently distinguish the undesirable signals, which has possitive effect on the increase in the material contrast and also on noise suppression. The merit of the invention is that ionized molecules of gases are separated by back scattered electrons, which increases the resolving power of the microscope substantially. Another advantage of the arrangement according to the invention is the obtained clear image of secondary electrons showing a high portion of the topographic contrast while the full signal of back scattered electrons is kept. No less important is also that surface contamination of the detection system has only a very little effect on the detector efficiencies.

Drawings overview

The invention shall be explained in more detail below with reference to drawings. Fig. 1 is a schematic diagram of the detection system with one single-crystal scintillator, fig.2 shows a detail of said single-crystal scintillator from the side of incidence of the primary electron beams, and fig. 3 represents the detail of the single-crystal scintillator seen from the side of the sample, and completed with the electrode system. Fig. 4 illustrates the detection process of the system with one single-crystal scintillator. Fig. 5 is a schematic diagram of the detection system with two levels, fig. 6 presents a detail of the single-crystal scintillator of the second level, and fig. 7 shows the detection process.

Examples

The detection system according to fig. 1 to 4 consists the single-crystal scintillator 6 constituted by square plates divided symmetrically into two mutually connected halves forming the left single-crystal scintillator 23 and the right single-crystal scintillator 22. The single-crystal scintillator 6, which is made from yttrium-aluminium garnet doped with cerium ($Y_3Al_5O_{12}$:Ce, YAG:Ce), is connected to the left and the right lightguides 19 and 18 using e.g. optical adhesive 40, and is placed in the sample chamber 11, continuing the differential chamber 2. The single-crystal scintillator is separated from the external bottom 3 of the differential chamber 2 by means of the sealing 45. The differential chamber 2 is separated from the pole piece 1 of the non-demonstrated lens of the microscope tube by the aperture stop 15. The

conical opening 46 having an angle 45° with the aperture stop 9, constituted by its smaller base on the side towards incidence 44 of the primary electron beams 33, is in the centre of the single-crystal scintillator 6. The conical opening 46 has the 300 nm thick system of the reflecting layer 34 of dielectric and gold on its inner surface. From the side where the sample 10 is placed, the single-crystal scintillator 6 is provided by the circular electrode system 7 being symmetrical around the axis 47 of the primary electron beams, and containing the electrode 26 and the external electrode 28 which are constituted by the conductive oxide layer 5 nm thick. Vacuum pumping out of the differential chamber 2, the pole piece 1 and the sample chamber 11 is provided by means of flanges 12, 13 and 14. The peripheral jackets of the left and the right single-crystal scintillators 23 and 22 are coated with the antireflecting layer 39. The contact areas of the left and the right single-crystal scintillators 23 and 22 mutually connected with adhesive 38 are coated with the reflecting dielectric layer 36 and the reflecting metal layer 37 adhering to it.

Another example is shown schematically in the fig. 5. Here, the detection system consists of two single-crystal scintillators forming two levels, where the above described single-crystal scintillator 6 is used as the first level, and the single-crystal scintillator 4 of the second level, constituted e.g. by a circular plate divided symetrically into two mutually connected halves, namely into the left single-crystal scintilator 20 and the right single-crystal scintillator 21, is placed in the differential chamber co-axially above the single-crystal scintillator 6 of the first level. The single-crystal scintillator of the second level 4 being also made from yttrium-aluminium garnet doped with cerium ($Y_3Al_5O_{12}$:Ce, YAG:Ce) is connected with the left and the right lightguides 17 and 16 using optical adhesive 40. The single-crystal scintillator 4 of the second level, constituted by the left single-crystal scintillator 20 and the right single-crystal scintillator 21 of the second level, has the second conical opening 42 with an angle 45° in its centre, greater base 43 of which is on the side towards incidence 44 of the primary electron beams 33. On its bottom base, the single-crystal scintillator 4 of the second level has the circular electrode 5 constituted by conductive oxide layer 5 nm thick, and by the ring 35 of reflecting layer of dielectric and gold 300 nm thick on the opposite side. Below the single-crystal scintillator 6 of the first level, the single-pole magnetic lens 8 is placed. Vacuum pumping out of the differential chamber 2, the pole piece 1 and the sample chamber 11 is also provided by means of flanges 12, 13 and 14.

The peripheral jackets of the left and the right single-crystal scintillators 20 and 21 of the second level are coated with the antireflecting layer 39 according to fig. 6. The contact areas of the left and the right single-crystal scintillators 20, 21 mutually connected with adhesive 38 are coated with the reflecting dielectric layer 36 and the reflecting metal layer 37 adhering to it.

In the both cases, the function principle indicated in fig. 4 and 7 is in substantial equality, and therefore it will be described for two-level arrangement. The primary electron beams 33 pass through the pole piece 1, the apeture stop 15 and through the differential chamber 2 , and enter the sample chamber 11 in which the sample 10 is placed in central axis of the magnetic field of the single-pole magnetic lens 8. The pole piece 1, the differential chamber 2 and the sample chamber 11 are pumped out differentially - e.g. the pressure is 10^{-3} in the pole piece 1 area, 10 Pa in the differential chamber 2, and 1000 Pa in the sample chamber 11. Interaction of the primary electron beams 33 in the place of incidence 44 upon the sample 10 causes generation of signal electrons consisting secondary electrons 29 and back scattered electrons at high and low angles of scanning 24, 25. The lightguides 16, 17, 18, 19 divert generated photons to the photomultiplier, which is not drawn here, where they are treated to image information. Secondary electrons 29 spreading helically around the axis 47 of the primary electron beams 33 in the magnetic field of the single-pole magnetic lens 8, pass through the aperture stop 9 and enter the differential chamber 2 where they deviate from their initial helical trajectory because of the shrinking magnetic field of the single-pole magnetic lens 8. Secondary electrons 29 are accelerated to the circular electrode 5 of the single-crystal scintillator of the second level 4 by means of electrostatic field which arises from the positive potential on the circular electrode 5. Secondary electrons 29 are detected in the single-crystal scintillator of the second level 4, which results in the topographical image. Secondary electrons 29 ionize gas molecules, and ions 30 move to the differential chamber 2 also helically.

Back scattered electrons, the trajectory of which is only little influenced by the magnetic field of the single-pole lens 8, pass through the electrode system 7 and hit the single-crystal scintillator 6 of the first level, and they are detected in this way, that the result is the material constrast of the sample 10. Reading the signals of the left and the right scintillators 23, 22 of the first level the topographical contrast of the sample 10 is obtained. Electrons back scattered from the sample 10 in high angle scanning 24 pass through the aperture stop 9 and through the circular electrode 5 of the single-crystal scintillator 4 of the second level where

they are detected. The result of this detection is the material constrast. In the case of reading the signals from the left and the right single-crystal scintillators 20, 21 of the second level, the result is the topografical contrast.

If positive voltage is supplied to the electrode system 7 of the single-crystal scintillator 6 of the first level, ions 30 generated by collisions of back scattered electrons 29 as well as ions 31 which has been generated by collisions of back scattered electrons in low scanning angle 25 with gas molecules, are accelerated towards the electrode system 7, which allows their detection.

Resulting image information is controlled by the sample 10 position, by the magnetic field of the single-pole magnetic lens 8, by the concentration of the secondary electrons 29 on the circular electrode 5, by the electrode system 7, by the collection of back scattered electrons in the single-crystal scintillators 6, 4 of the first and the second levels, and by the collection of ions in the electrode system 7.

Under high pressure in the sample chamber 11, the sample 10 is placed as near as possible to the detector; size of the opening, i.e. the aperture stop 9 plays the significant role. In the case of the one-level arrangement of the detection system, the great part of back scattered electrons returns to the differential chamber 2. In the case that the second level is used, back scattered electrons are captured and treated. The advantage of the two-level arrangement is that four independent signals can be obtained as a result of devided arrangement of the single-crystal scintillators. After mathematic treatment of respective signals, i.e. after their addition or subtraction, increase of the material respectively the topografical contrasts of sample 10 observed can be achieved.

The industrial applicability

The invention can be applied in the industrial branches where it is necessary to observe a surface structure of materials containing water or heavy liquids using electron microscopy with great magnification, and possibly to observe the surface structure of non-conductive materials with great magnification and great resolution. The invention can be applied eg. in

electrotechnology, semiconductor technique, in ceramic, glass and textile indurstries, in rubber, pharmaceutical and chemical industries, at plastics processing, in biology and medicine.

Claims

1., Detection system of a scanning electron microscope with the tube separated from the sample chamber by means of the differential chamber consisting the single-crystal scintillator with the aperture stop divided into two halves characterized in that the single-crystal scintillator (6) based on double yttrium-aluminium oxides or on yttrium silicates activated by trivalent cerium, has the conical opening (46) in his centre whose smaller base is on the side near to incidence of the primary electron beams (33), and constitutes the aperture stop (9), and having said conical opening (46) being coated with the reflecting metal layer (37) on the contact surfaces of both halves, and with the reflecting layer (34) of dielectric and heavy metal on the inner surface, and where said single-crystal scintillator (6) is positioned between the right and the left lightguides (18,19) in the sample chamber (11) above the sample (10), while it is separated from the external bottom (3) of the differential chamber (2) by the sealing (45), and from the side of the sample (10) placing it is equipped with the circular electrode system (7) consisting at least two electrodes (27,28) symmetrical around the axis (47) of the primary electron beams (33).

2., Detection system of claim 1 characterized in that the single-crystal scintillator (6) forms the first level, and co-axially above said single-crystal scintillator (6) of the first level, the single-crystal scintillator (4) of the second level is placed being based on double yttrium-aluminium oxides or on yttrium silicates activated by trivalent cerium, and divided into two halves, and having the second opening (42) in its centre coated with the reflecting metal layer (37) on the contact surfaces of the both halves, where said single-crystal scintillator (4) of the second level equipped with the ring (35) of the reflecting layer of dielectric and heavy metal from the reverse side of incidence (44) of the primary electron beams (33), and having greater base of the second conical opening (42) on the side towards incidence (44) of the primary electron beams (33), is placed between the left and the right lightguides (17,16) in the differential chamber (2), and it is equipped with the circular electrode (5) on its bottom base.

3., Detection system of claim 1 or 2 characterized in that the single-pole magnetic lens (8) is placed below the single-crystal scintillator (6).

4., Detection system of claim 1 characterized in that the single-crystal scintilator (6) is constituted by a circular plate divided into two halves symmetrically and connected each other.

5., Detection system of claim 1 characterized in that the single-crystal scintillator (6) is constituted by a square plate divided into two halves symmetrically and connected each other.

6., Detection system of claim 1 characterized in that the single-crystal scintillator (6) is constituted by a rectangular plate divided into two halves symmetrically and connected each other.

7., Detection system of claim 2 characterized in that the single-crystal scintillator (4) of the second level is constituted by a circular plate divided into two halves symmetrically and connected each other.

8., Detection system of claim 2 characterized in that the single-crystal scintillator (4) of the second level is constituted by a square plate divided into two halves symmetrically and connected each other.

9., Detection system of claim 2 characterized in that the single-crystal scintillator (4) of the second level is constituted by a rectangular plate divided into two halves symmetrically and connected each other.

10., Detection system of claims 1 characterized in that the conical opening (46) has an angle 40°-70°.

11., Detection system of claims 2 characterized in that the conical opening (42) has an angle 40°-70°.

12., Detection system of claims 1 and 2 characterized in that the peripheral jackets of the halves of the single-crystal scintillators of the first level (6) and the second level (4) are coated with the antireflecting dielectric layer (39).

13., Detection system of claim 1 characterized in that the right and the left single-crystal scintillators (22,23) of the first level are made from single crystals of yttrium-aluminium garnet doped with cerium.

14., Detection system of claim 1 characterized in that the right and the left single-crystal scintillators (22,23) of the first level are made from single crystals of yttrium-aluminium perovskite doped with cerium.

15., Detection system of claim 1 characterized in that the right and the left single-crystal scintillators (22,23) of the first level are made from single crystals of yttrium silicate doped with cerium.

16., Detection system of claim 2 characterized in that the right and the left single-crystal scintillators (20,21) of the second level are made from single crystals of yttrium-aluminium garnet doped with cerium.

17., Detection system of claim 2 characterized in that the right and the left single-crystal scintillators (20,21) of the second level are made from single crystals of yttrium-aluminium perovskite doped with cerium.

18., Detection system of claim 2 characterized in that the right and the left single-crystal scintillators (20,21) of the second level are made from single crystals of yttrium silicate doped with cerium.

19., Detection system of claim 2 characterized in that the left single-crystal scintillator (20) of the second level, the left single-crystal scintillator (23) of the first level, the right single-crystal scintillator (21) of the second level, and the right single-crystal scintillator (22) of the first level are combined from single crystals of yttrium-aluminium garnet doped with cerium or from single crystals of yttrium-aluminium perovskite doped with cerium or from yttrium silicate doped with cerium.

20., Detection system of claim 1 c h a r a c t e r i z e d i n t h a t the left single-crystal scintillator (23) of the first level and the right single-crystal scintillator (22) of the first level have the reflecting dielectric layer (36) under the reflecting metal layer (37) on their contact areas.

21., Detection system of claim 2 c h a r a c t e r i z e d i n t h a t the left single-crystal scintillator (20) of the second level and the right single-crystal scintillator (21) of the second level have the reflecting dielectric layer (36) under the reflecting metal layer (37) on their contact areas.

22., Detection system of claim 1 c h a r a c t e r i z e d i n t h a t the electrodes of the circular electrode system (7) are constituted by a conductive oxide layers.

23., Detection system of claim 22 c h a r a c t e r i z e d i n t h a t the conductive oxide layer of the circular electrode system (7) is 0.5-10 nm thick.

24., Detection system of claim 2 c h a r a c t e r i z e d i n t h a t the circular electrode (5) is constituted by a conductive oxide layer.

25., Detection system of claim 24 c h a r a c t e r i z e d i n t h a t the conductive oxide layer of the circular electrode (5) is 0.5-10 nm thick.

26., Detection system of claim 1 c h a r a c t e r i z e d i n t h a t the reflecting layer (34) of dielectric and heavy metal is 100-1000 nm thick.

27., Detection system of claim 2 c h a r a c t e r i z e d i n t h a t the ring (35) of the reflecting layer of dielectric and heavy metal is 100-1000 nm thick.

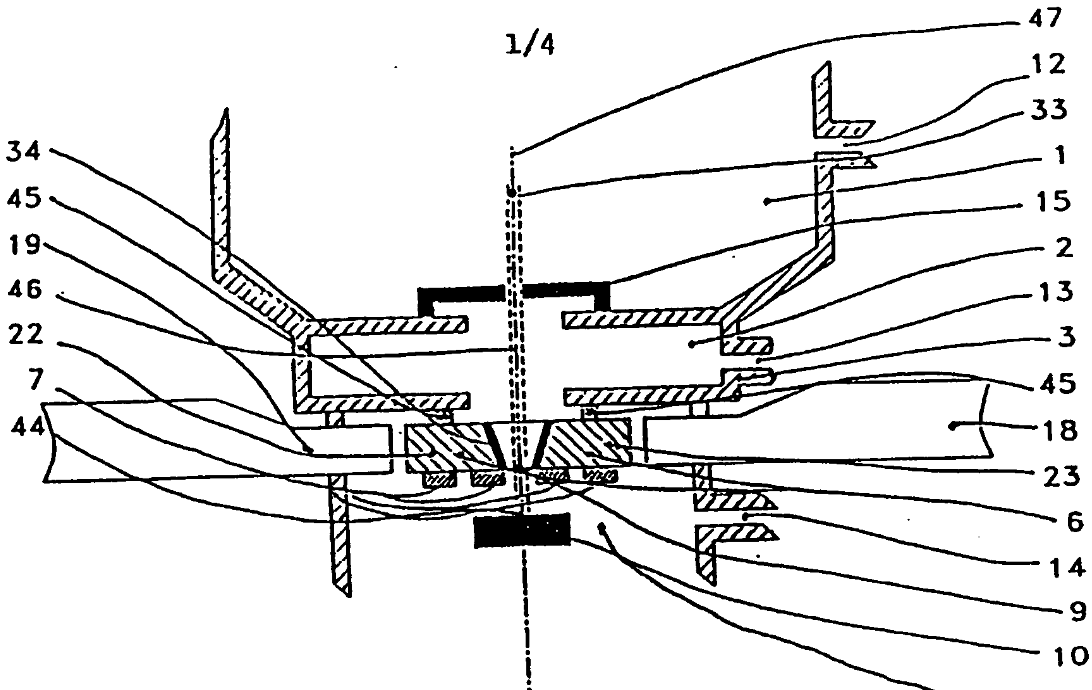

FIG. 1

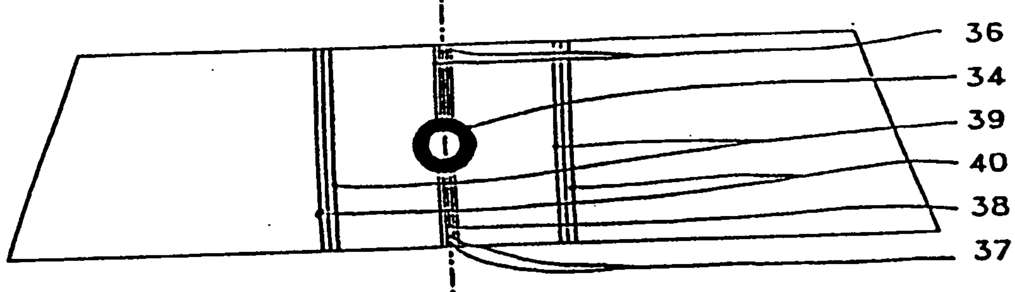

FIG. 2

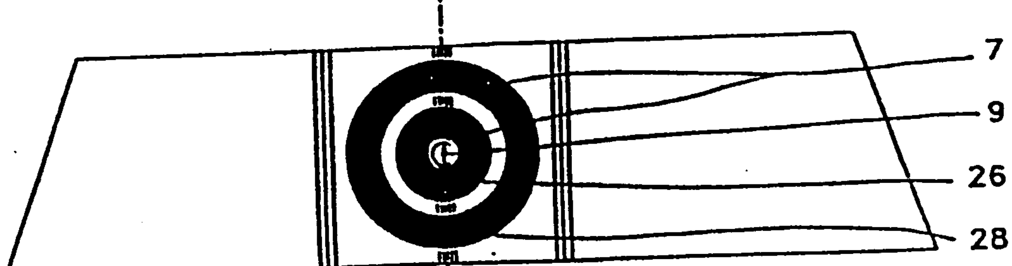

FIG. 3

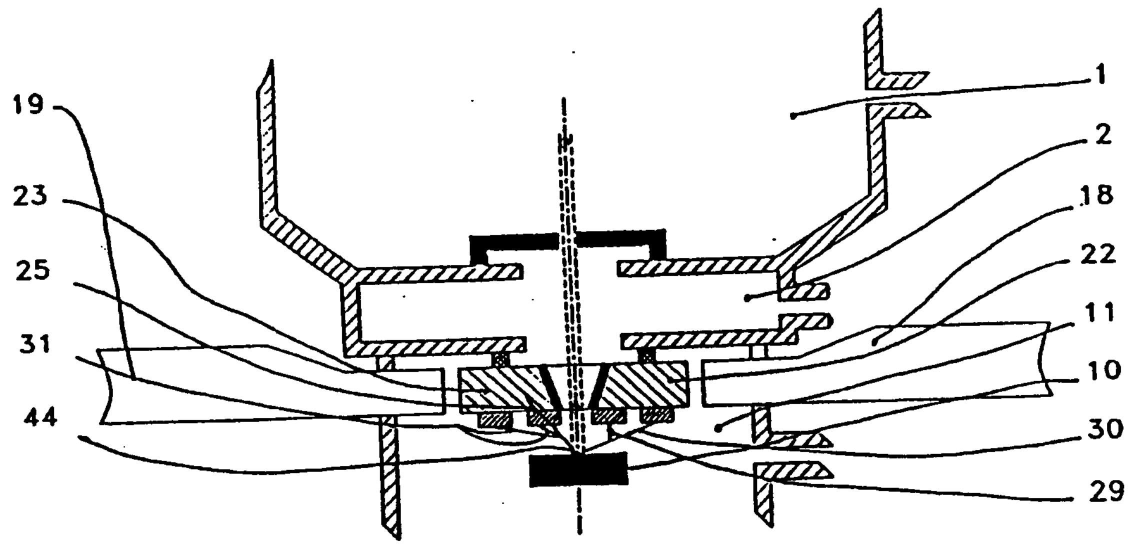

FIG. 4

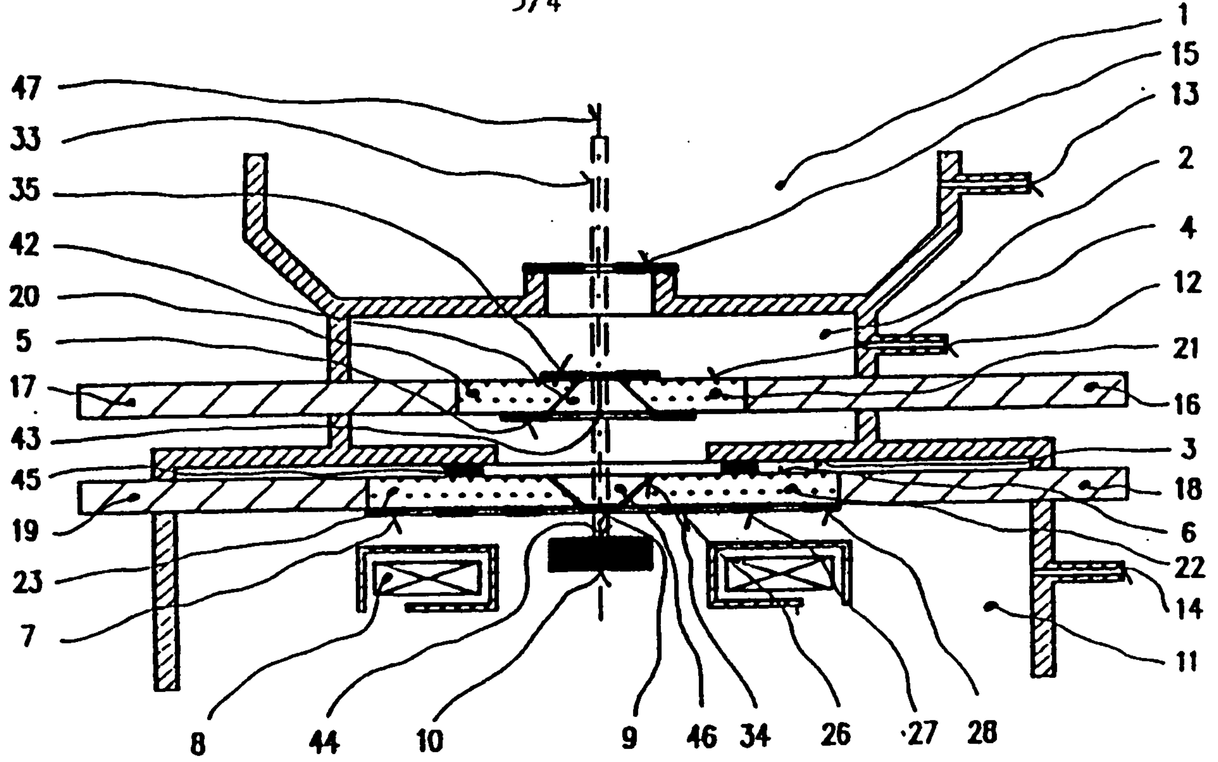
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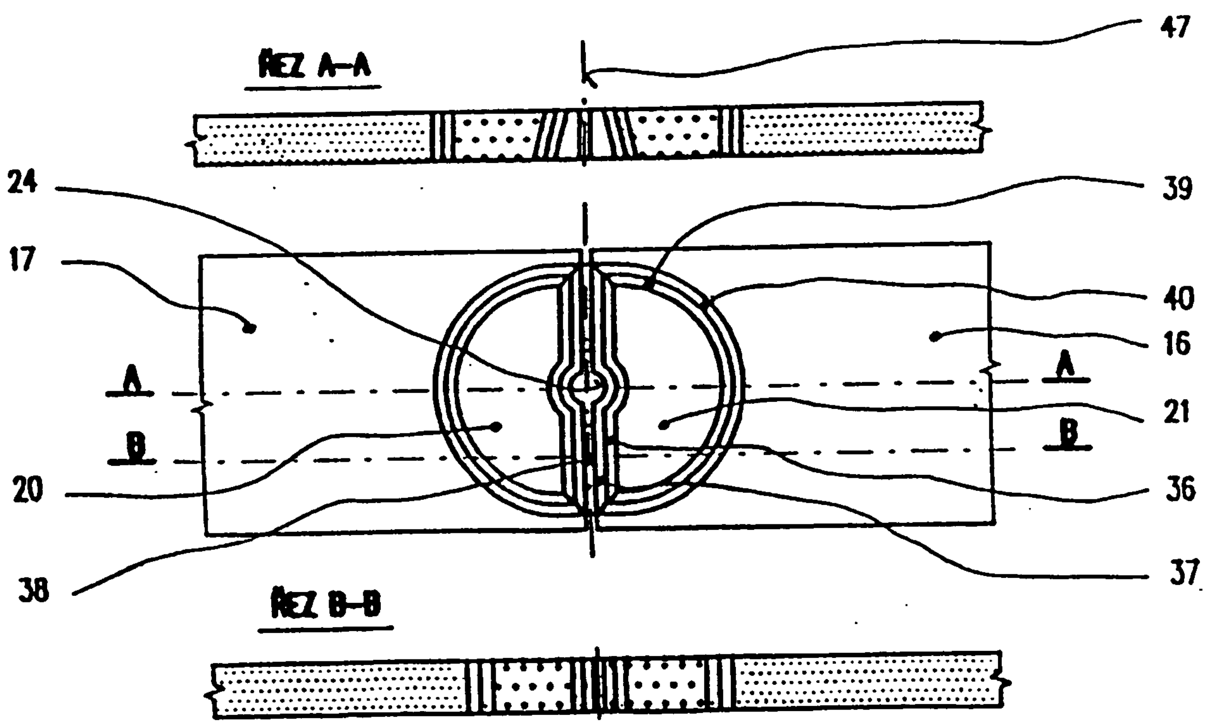
FIG. 5


ŘEZ A-A
47
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ŘEZ B-B

FIG. 6

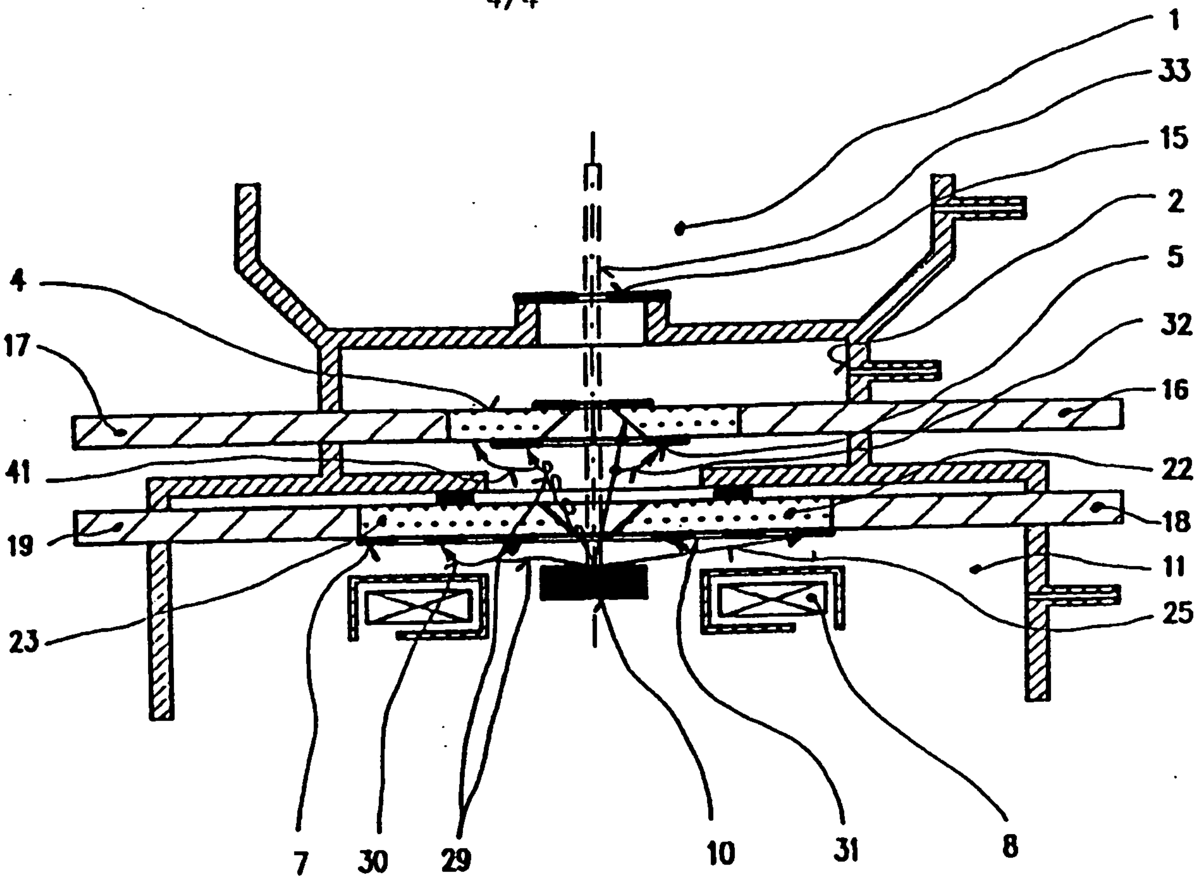

FIG. 7

INTERNATIONAL SEARCH REPORT

Inter   onal Application No
PCT/CZ 98/00014

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6   H01J37/244

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6   H01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 97 07525 A (PHILIPS ELECTRONICS NA) 27 February 1997 see page 20, line 8 - page 23, line 21; figures 7-9 ---	1
A	DE 35 00 903 A (ZEISS CARL FA) 17 July 1986 see abstract see page 9, line 16 - page 10, line 8; figures 1,4 ---	1
A	DE 39 25 949 A (SPECHT HERBERT DR) 7 February 1991 see column 5, line 38 - line 60; figure 1 ---	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
6 July 1998	13/07/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Schaub, G

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter nal Application No
PCT/CZ 98/00014

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9707525 A	27-02-1997	EP 0786145 A	30-07-1997
DE 3500903 A	17-07-1986	EP 0191293 A	20-08-1986
		JP 61164179 A	24-07-1986
		US 4700075 A	13-10-1987
DE 3925949 A	07-02-1991	NONE	